Increasing Retention of Under-represented Minority Students in Engineering: The Diversity Programs Office - Scholars Program (DPO-SP)

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(c-2) Five Other Significant Publications 1. Caldwell, T.D., Foster, K., Lane, T., Caldwell, R.A., Vergara, C.E., and Sticklen, Jon. What Happens After a Summer Bridge Program: The DPO Scholars Program. Accepted for publication in ASEE 2011. Paper 1790.

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Increasing Retention of Under-represented Minority Students in Engineering: The Diversity Programs Office - Scholars Program

Abstract

The College of Engineering (COE) at Michigan State University (MSU) has developed two programs that address impediments faced by students from economically disadvantaged areas. Students from low socio-economic areas are recruited by the Diversity Programs Office (DPO) to take part in a summer bridge experience that includes academic pre-classes and social network building. The capacity of the summer bridge program is 50 students per year. The program includes a rigorous set of math tutorials and focused work sessions - all done in the social context of a learning community. Most of the summer bridge students who matriculate to MSU in engineering will flow directly into the DPO Scholars Program (DPO-SP) program. Established in Fall 2009, DPO-SP is an academic yearlong program funded internally by MSU; it incorporates components and activities designed to provide a structured social and academic support system for academically at risk first year students. The structure of the program represents a successful model to retaining undergraduate engineering and more generally STEM students. In this paper we will describe the structure of the program and discuss our findings including the program evaluation results focusing on two main aspects, academic and social. We will present the short and long-term impacts that the program and its components have on participants, and discuss our efforts to extend the program to include other academic units within MSU.

Introduction

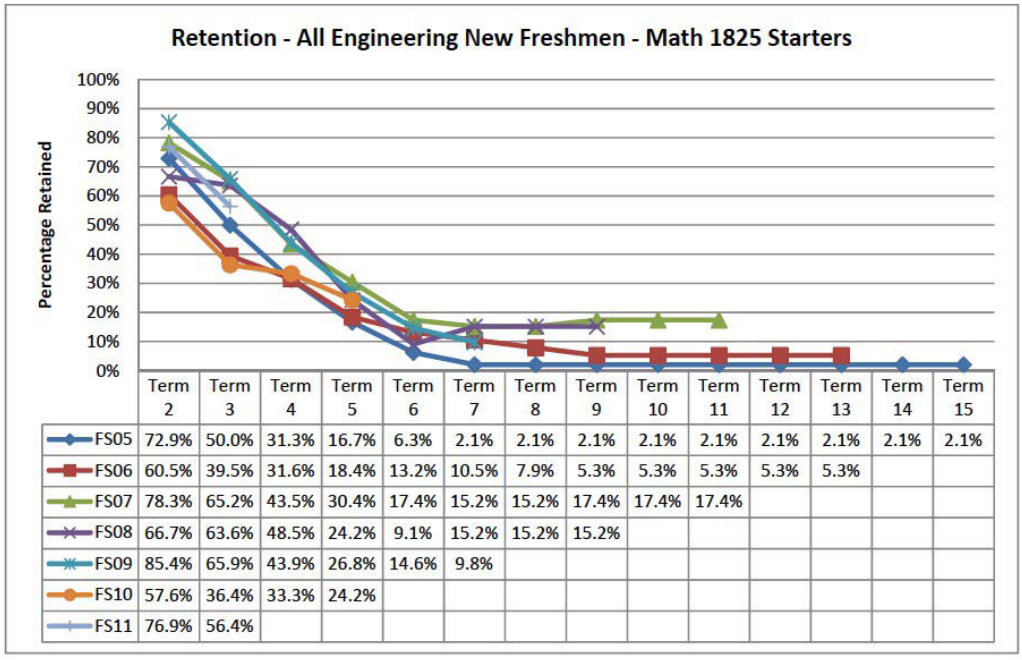
Despite efforts to broaden participation and diversity in STEM disciplines in general and in engineering specifically, student success remains a challenge.[1-3] Failure to retain a diverse pool of students in STEM disciplines will have far-reaching, negative implications for the U.S. economy and for the U.S. in general.[4]

Students who start with a weak mathematical background are already at a disadvantage in coping with curricular requirements and course sequences that require a solid calculus preparation. Miller and colleagues[5] have shown that students entering college "calculus ready" have higher retention rates in engineering programs. In addition to academic challenges, students matriculate with a distinct set of attitudes and expectations that reflect their experiences in their social context i.e. family, community, and economic background. According to Foor, [6] students from low socioeconomic backgrounds and who attended resource-poor high schools enter engineering programs on an uneven plane.

For example in the College of Engineering (COE) at MSU a large number of under-prepared students start their engineering mathematics coursework below calculus or even below college algebra. Figure 1 shows the retention data for *all new freshmen* that start their mathematics coursework with Math 1825, a no-credit introductory math. A student starting in 1825 will require approximately two years on average to reach calculus. The number of these students who achieve admission to an engineering major is under 10% as depicted in Figure 1 taking Term 7 values (a term is a semester).

In the College of Engineering (COE) at MSU there is a two-tiered admission process, students are first accepted by the university based on general criteria; students then self-select for a discipline in engineering. After accumulating 56 credit hours or when core technical courses have been completed, a student "goes up" for admission in the major he/she has selected. All engineering majors are GPA limited enrollment programs, ranging from 3.0 to 2.7.

The decision to admit to the engineering major is nominally made near Term 7. Our internal statistics indicate that students who achieve disciplinary admission to an engineering major are typically admitted within three years of matriculation. For students who are admitted to an engineering major, the graduation rate is almost identical for all students as shown in Term 7 data in Figure 1. In other words, students from all backgrounds who persevere are eventually admitted to a disciplinary major even if they start with zero credit mathematics (Math 1825). Thus, the first three years are critical for the success of undergraduate students and we must provide a supportive environment until they are admitted into their academic majors. This is particularly important to increase retention among under represented minorities (URM) and ensure diversity among the population of students.



	Term 2	Term 3	Term 4	Term 5	Term 6	Term 7	Term 8	Term 9	Term 10	Term 11	Term 12	Term 13	Term 14	Term 15
FS05	72.9%	50.0%	31.3%	16.7%	6.3%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%	2.1%
FS06	60.5%	39.5%	31.6%	18.4%	13.2%	10.5%	7.9%	5.3%	5.3%	5.3%	5.3%	5.3%		
FS07	78.3%	65.2%	43.5%	30.4%	17.4%	15.2%	15.2%	17.4%	17.4%	17.4%				
FS08	66.7%	63.6%	48.5%	24.2%	9.1%	15.2%	15.2%	15.2%						
FS09	85.4%	65.9%	43.9%	26.8%	14.6%	9.8%								
FS10	57.6%	36.4%	33.3%	24.2%										
FS11	76.9%	56.4%												

Figure 1: Retention data for *all new freshmen* that start their mathematics coursework with Math 1825. Term/semester 12 retention rate for these students is under 10%. The decision to admit to the engineering major is nominally made near Term 7.

The COE at MSU has developed two programs that address impediments faced by students from economically disadvantaged areas. Students from low socio-economic areas are recruited by the Diversity Programs Office (DPO) to take part in a summer bridge experience that includes academic pre-classes and social network building. The capacity of the summer bridge program is 50 students per year. The program includes a rigorous set of math tutorials and focused work sessions - all done in the social context of a learning community. Most of the summer bridge students who matriculate to MSU in engineering will flow directly into the DPO Scholars

Program (DPO-SP) program.[7]

In the following sections we will describe the structure of the DPO-SP program and discuss the program evaluation results focusing on two main aspects, academic and social. We will present the short and long-term impacts that the program and its components have on participants, and discuss our efforts to extend the program to include other academic units within MSU.

Program Description

Established in Fall 2009, DPO-SP is an academic yearlong program funded internally by MSU, and designed to provide a highly structured *academic* and *social* support system for first year students who are enrolled in a STEM discipline and who come from areas of low economic status. Most of the students who participate in the summer bridge program will flow directly into the DPO-SP. The structure of the program represents a successful model to retaining undergraduate engineering, and more generally STEM students. Two critical factors differentiate the SP from a number of previously implemented initiatives:

- Each cohort is offered a two-year program. This allows the DPO to provide a solid support structure for each participant during the two most critical years of a college student's experience.
- All components of the program are mandatory: A student cannot opt out of one component and still participate.

Participants are recruited and selected from MSU students who declare Engineering and place into Math 1825 (no-credit introductory math) or Math 103 (college algebra) or those who declare Engineering and are admitted through the College Achievement Admissions Program (CAAP) a retention initiative designed to address the needs of first generation and low income students, and students who meet other participant criteria.

The DPO-SP Program includes the following components designed to support students during their transition from high school into university life:

- Mandatory participation in the Engineering and Science Summer Academy (ESSA). ESSA is a six-week, pre-freshmen summer bridge program that provides information about support units and systems across campus. It also exposes participants to successful academic skills to deal with courses that are critical to the success of all college students but, in particular, students in STEM majors:
    - Mathematics
    - Chemistry/Biology
    - Writing
- Mandatory schedule building by DPO staff during their first full academic year and approval of schedule during the second academic year. Due to the amount of time spent with participants during ESSA, DPO staff are better positioned to provide a more balanced and appropriate schedule to suit individual participants'.
- Mandatory assignment to the Engineering Residential Experience in Wilson Residence Hall.

- Mandatory STEM sections of Math and Science courses. This provides SP participants with an opportunity to enjoy smaller class sizes and to network with other students who are STEM focused and who will have shared experiences as the move through their respective curriculums.
- Mandatory, nightly, 2.5-hour recitation sessions Monday-Thursday during the academic year. These sessions provide additional instruction and academic assistance that will further position our students for academic success.
- Mandatory bi-weekly meetings with DPO staff. We must stay connected with and actively, intrusively engaged with our students. This will also reinforce the point that we are participants in their success!
- Mandatory enrollment in EGR 160: Diversity in Engineering and Professional Preparation. These courses provide information on time management, studying skills, personal assessment, professional preparation, academic success and explore the importance of diversity in the engineering profession.
- Mandatory participation in the Leaders Encouraging Academic Success (LEAD) peer-mentoring program. This component allows students to learn from and work with 3rd, 4th and 5th year students providing an opportunity for peer accountability, critical to the success of any retention program.

Students who successfully complete the first year of the program are awarded a $1000 scholarship and placement in a summer residential research assistant position. This research assistant appointment provides a $1,100-$3,500 stipend, as well as an opportunity for students to connect with faculty much faster than if they waited until their junior year or upon acceptance into their college. Connection with faculty is another critical piece of a retention initiative. During the second year, the students would continue with all program initiatives, but they would also serve as peer mentors for the cohort that will begin SP that same fall semester.

At the conclusion of the ESSA, the pre-freshmen summer bridge program, participants take a second math placement exam. The objective of this second examination is two fold:

- Students who place higher on this exam will enroll in the higher math class.
- It provides data about gains in math competencies after participating in the program.

Pre and post results showed an impressive boost in mathematics course placements:

- For Cohort 2012, (17 students): 88% scored higher on the Math Placement Exam.
- For Cohort 2013, (41 students): 94% of the total cohort increased their Math Placement Exam score; 70% moved up at least one math class and the average score increase was 44%. Seventy nine percent of the MTH 1825 starters moved up at least one math class; 100% of the MTH 103 starters moved up at least one math class; 42% of the MTH 116 starters moved up to MTH 132.

Considering that a) these students began their mathematics coursework with Math 1825, a no-credit introductory mathematics, and b) that a student starting in 1825 will require approximately two years on average to reach calculus, the boost in mathematics course placements achieved by DPO-SP participants, both increases retention and reduces time to degree.

Additional retention findings are summarized in table 1. These findings are from internal DPO data and are not aligned to the COE retention data shown in Figure 1.

Table 1. DPO-SP Retention in Engineering and other STEM disciplines

SP Cohort	Retained in ENGR (%)	Retained in STEM (%)	Retained at University (%)
2009 (through 6th semester) n=23	61	70	78
2010 (through 4th semester) n=18	61	72	77
2011 (through 2th semester) n=18	56	67	78

Program Evaluation

The Center for Engineering Education Research (CEER) at MSU conducts the evaluation for the Scholars Program. Using quantitative and qualitative methods for data collection and analyses the evaluation focuses on two main aspects, *academic* and *social*. The overarching goal is to understand the short and long-term impacts that the program and its components have on participants. Data collection includes: surveys at the start and end of the program (including open and close-end items), focus groups (mid-program) and semi-structured interviews (longitudinal follow up beginning with the 2009 cohort).

Survey data are analyzed using Qualtrics survey software and Excel. The focus groups and the interview data are analyzed using qualitative data analysis and research software (Atlas.Ti). The interviews and focus groups are transcribed verbatim and then segmented into units that contain similar ideas or themes. Initial coding structures are defined by the evaluation objectives. The framework guiding the coding and analyses includes:

- Participants' understanding about the College of Engineering (COE)
    - Understanding about the engineering profession.
    - Ideas about academic expectations in the COE
    - Views about the social expectations in the COE
- Participants' expectations about the program
    - Academic
    - Social
    - Inform choice of major
- Participants' experiences and views about the program.

Findings

Survey Analyses
The analyses correspond to the 2012-2013 cohort and include data from the start and exit surveys, the focus groups, and preliminary results from three pilot interviews.
Eighty one percent of participants rated the program as excellent and 18% rated it as good.

Acceptance and continued enrollment in the COE: Comparing the responses from students who

took both the start and exit surveys (n=16) we see that in the start survey 75% indicated that they 'will be accepted' and 25% indicated that they had 'a better than even chance' of being accepted in the COE. After participating in the program the response distribution changed and 63% of the participants indicated they 'will be accepted', 19% that they have 'better than even chance' and 18% that they have a 'worse than even chance' or will not be accepted (Figure 2). This wider distribution might be related to the fact that after participating in the program students have a better understanding about the requirements to be admitted to the COE and are more realistic about their expectations.

Fifty six percent and 43% of participants indicated that the program had a "large influence" or a "moderate influence" in their decision to remain in the COE respectively.

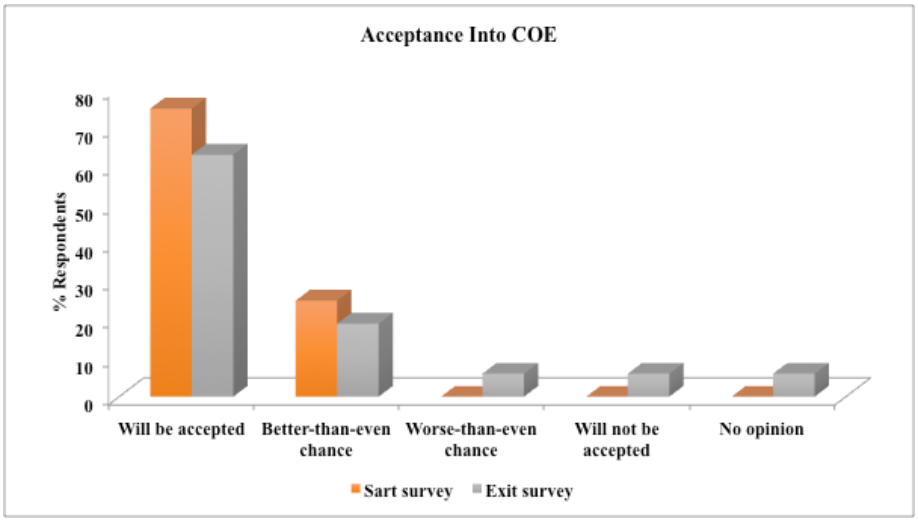


Figure 2: Students' opinion about acceptance into the COE. Only students who completed both the start and exit surveys are included in the analyses (n=16).

Understanding COE professional, academic and social expectations: As indicated in Figure 3 for all categories the calculated mean is above 3.6 indicating that students "strongly agree" or "agree" that participation in the program influenced their understanding about the COE professional, academic and social expectations.

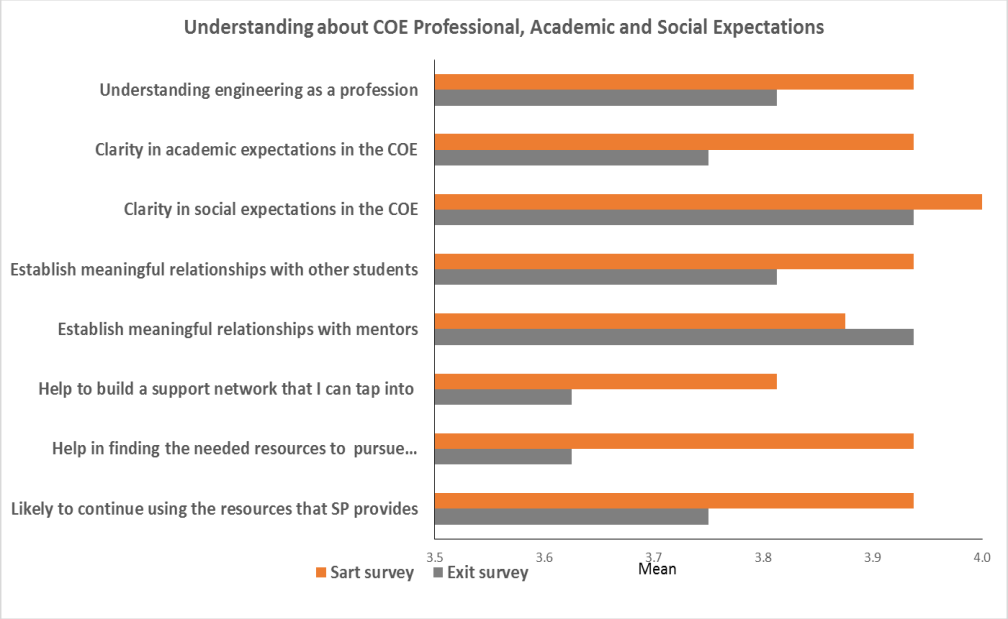


Figure 3: Students' opinion about the Scholars Program influence on understanding the COE professional, social and academic expectations. Only students who completed both the start and exit surveys are included in the analyses (n=16).

Improved academic proficiency: When asked about their expectations (start survey) and their opinion (exit survey) about the usefulness of the DPO-SP Program in improving their academic proficiency, 88% and 12% of participants expressed that the program was "extremely" and "moderately" useful.

Usefulness of program components: Participants were asked to rate each one of the program components. The responses are summarized in Figure 4.

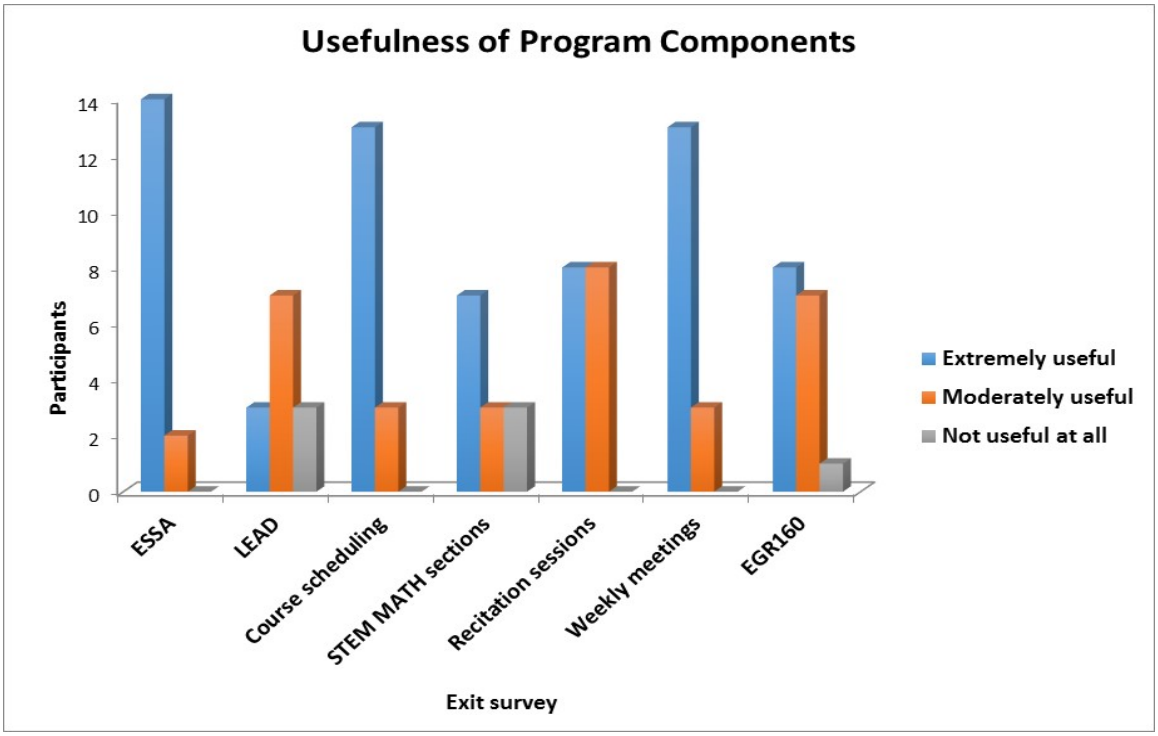


Figure 4. Participant's opinions about specific program components. Data from exit survey are included for analyses (n=16).

Focus Groups and Interview Analyses

Towards the middle of the fall 2012 term, we conducted one-hour focus groups with the students enrolled in the SP program. The objective was to gain additional information about participants' responses in the surveys. Students were divided in three groups of approximately 6 students and a team of two researchers facilitated each group session.

The interview analyses included in this report are preliminary analyses from a set of three pilot interviews that we have conducted to date. The interview process is still ongoing.

The findings are organized into academic and social impacts. Quotations from the focus groups and interviews are included to exemplify the coding and categorization process.

Self-reported Academic Impacts

Participants indicated that the SP program helped them understand better the academic requirements that are unique to the COE. Some participants explicitly indicated that before participating in the SP programs they were not aware of the specific and unique academic requirements in the COE. Exemplifying quotes include:

> "Mr. X [DPO staff] definitely made a point about letting us know what it takes to get into the COE with a GPA everything [sic]. I think he's gone over that about two or three times so far"

> "So, the engineering 160, they show you the steps, the process in which you need to be admitted to the COE. How you need to get your GPA. How to calculate your GPA and things of that nature."

> "Before participating [in DPO-SP] I had no knowledge. […] I thought it was like any other university, where you would come for two years, take classes, and then you would apply to get into the College, and either you would get in or you wouldn't." (Interview data)

In terms of specific academic deficiencies, participants reported that the program helped correct academic problems that impact admittance to the COE. A student indicated:

> "During the [DPO] summer program, the math that I was placed into definitely helped me because I struggled through Algebra II and Pre-Calc. because I was missing part of key concepts for those classes".

Another finding relates to the transition from high school to college. Students indicated that participation in the program contributed to their understanding about the difference between the high school environment and the college environment. The program increased their awareness about the importance of recognizing this transition and taking the adequate steps to be successful in the college environment. Participants mentioned specific aspects such as finding their way around campus, not being intimidated by a big lecture hall environment, taking simple steps like sitting in the front of the classroom and going to the instructor's office hours on a regular basis. Exemplifying quotes include:

> "They did a really good job of explaining how that there is a big transition from high school to college. But, not just in, like, you know, adjusting, but and really how these classes are going to affect stuff […] because everything builds on each other".

> "When I got here to be like wow, this [DPO-SP] was such an advantage […]. I wasn't even shocked when I went in to like those big lecture halls. I was like, what did I learn [in DPO-SP]? Let me sit in the front."

> "I go to my professor's office hours, like, almost every professor, at least twice a week, like, asks [sic] for help […]. I came here and I didn't even feel like a freshman. I felt like I had the lay of the land and everything."

Participants indicated that as a result of their participation in the program they learned better study habits and learned how to work using structured schedules that allow for balance between their studies and their social life:

> "Yea, he [DPO-SP staff] told me to make that schedule and a schedule is something I have to follow until the end of semester"

> "Well, definitely the recitations Mon through Thu definitely helped me get my homework done. And they also provide help just in case I need help with the homework. So that's definitely helped me".

The pilot interviews included three graduating seniors who had participated in the DPO-SP program first offering in 2009. Regarding their study habits these students indicated:

> "Yea, and plus with the form even though like it's something you really think about all the time [sic]. Like how many hours you study a week on a certain subject. Actually writing it down, you actually think how much you're spending on that subject. And you can change it based on what you see. So that definitely helps a little bit."

> "I also feel like the schedule that I had during the summer [DPO-program] is helpful to now because I try to base everything now off the schedule I did back in the summer. So like classes, then eat and my own free time to study. And then study some more and then go to bed early.

> "[in high school] I didn't have study habits at all. DPO-SP it kind of taught you those habits, and I learned scheduling my time. So basically my days mimic what our days were like in the DPO-SP […]. So Sunday through Friday we work hard, Friday night and Saturday we have fun. […] so really Sun, to Thu, those evenings from basically like 7:00 to 10:00 pm, that's natural, like my brain just goes "study time." From all the years of being in that recitation at a given time I still just have it—you know, I got that habit instilled to this time study from this time [sic]."

Self-reported Social Impacts

Participants indicated that participation in the program provided a strong and long-lasting support network, they often referred to it as their "DPO family". For example one student commented:

> "They [DPO] have activities where you can do teamwork based projects and things like that. So, we went to the movies together. We went to eat together. You know, it got to the point where everybody knew each other and we thought of each other as a family, I guess. So, that was one big thing about the social impact for me from the DPO anyway".

Participants also commented about having the opportunity [through the SP] to learn about the importance of teamwork and collaboration as part of the engineering profession.

> "As well as how to be involved in engineering projects as you talked before about being socially integrated. Because, we have to do projects along the road with sometimes it's students that we have never met before, so we have to come up with ideas. We have to create a project".

> "Also through EGR 160 they have been introduced to team work, networking, work ethics and have understood that this profession needs lots of interaction".

Conclusions

The DPO-SP program provides critical academic and social support for students during their first two years of their undergraduate experience. Our data indicates that participation in the program contributes to:

- Better understanding about the academic requirements that are unique to the College of Engineering. Participants indicate that before participation in the DPO-SP they were not aware of the academic requirements to be admitted to the College of Engineering.
- Participants learning to work using structured schedules that allow for balance between studies and social life. This structure resulted in better study habits, and laid a balanced foundation, which many of them maintain beyond their freshman year.
- Foster student socialization not only to the engineering profession but also allows them to create lasting social networks of peers going through the same experience of transitioning from the high school to college life.
- Providing a strong support network often refer to as their [participants'] "DPO family".
- Better understanding of engineering as a profession.

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